

CLAIMS

What is claimed is:

- 1 1. A method, comprising characterizing congestion within a traffic stream of interest in a
2 communication network as self-induced congestion or cross-induced congestion by analyzing
3 a correlation result of a time series of throughput data of the traffic stream of interest and
4 making the characterization based on power spectrum features found in the correlation result.
- 1 2. The method of claim 1 wherein the correlation result is obtained through a Fourier analysis
2 of the time series.
- 1 3. The method of claim 1 wherein the correlation result is obtained through a wavelet
2 analysis of the time series.
- 1 4. The method of claim 1 wherein the correlation result is obtained through a mathematical
2 process based on locating periodicities in the time series.
- 1 5. The method of claim 1 wherein the characterization is made at a node in the
2 communication network that is downstream from the congestion.
- 1 6. The method of claim 1 wherein the characterization is made at a node in the
2 communication network that is upstream of the congestion.
- 1 7. The method of claim 1 wherein the power spectrum features comprise one or more of a
2 distinctive peak within the power spectrum and area content of the power spectrum at low
3 frequencies.
- 1 8. The method of claim 7 wherein the congestion is characterized as self-induced when the
2 power spectrum exhibits one or more well-defined peaks and little power at low frequencies.

1 9. The method of claim 7 wherein the congestion is characterized as cross-induced when the
2 power spectrum does not exhibit well-defined peaks and has relatively high power at low
3 frequencies.

1 10. A communication network, comprising:

2 one or more nodes at which traffic streams are buffered; and
3 at least one monitor node coupled in a communication path with one of the nodes at
4 which traffic streams are buffered, the monitor node configured to take a sample of
5 throughput data for a traffic stream of interest, to compute a correlation result for the sample,
6 and to determine whether congestion exists along the communication path of the traffic
7 stream of interest according to whether or not certain features are found in the correlation
8 result.

1 11. The communication network of claim 10 wherein the correlation result is obtained
2 through a Fourier analysis of the time series.

1 12. The communication network of claim 10 wherein the correlation result is obtained
2 through a wavelet analysis of the time series.

1 13. The communication network of claim 10 wherein the correlation result is obtained
2 through a mathematical process based on locating periodicities in the time series.

1 14. The communication network of claim 10 wherein the monitor node is configured to
2 determine that self-induced congestion exists along the communication path of the traffic
3 stream of interest if the correlation result exhibits one or more well-defined peaks and little
4 power at low frequencies in the face of packet loss within the traffic stream of interest.

- 1 15. The communication network of claim 10 wherein the monitor node is configured to
2 determine that cross-induced congestion exists along the communication path of the traffic
3 stream of interest if the correlation result exhibits one or more not well-defined peaks and
4 relatively high power at low frequencies in the face of packet loss within the traffic stream of
5 interest.
- 1 16. The communication network of claim 10 wherein the monitor node is further configured
2 to implement a congestion control process according to whether or not cross-induced
3 congestion or self-induced congestion is found in the communication path of the traffic
4 stream of interest.
- 1 17. The communication network of claim 10 further comprising a control node configured to
2 implement a congestion control process according to whether or not cross-induced
3 congestion or self-induced congestion is found in the communication path of the traffic
4 stream of interest.
- 1 18. A method comprising analyzing a sample of throughput data for a traffic stream of
2 interest in a communication network to produce a power spectrum of the sample and
3 comparing the power spectrum to stored replicas of power spectrums of known congestion
4 sources within the communication network to determine a source of congestion for the traffic
5 stream of interest.
- 1 19. The method of claim 18 wherein peaks of the power spectrum of the sample are
2 compared to peaks of the stored replicas of the power spectrums of the known congestion
3 sources.

- 1 20. The method of claim 18 further comprising applying a congestion control process to the
2 traffic stream of interest based on results of the comparison.
- 1 21. A method, comprising analyzing a sample of throughput data for a traffic stream of
2 interest in a communication network to produce a power spectrum of the sample, the power
3 spectrum having one or more peaks, and identifying bandwidth mismatches within the
4 networks by the peaks.
- 1 22. The method of claim 21 wherein the analyzing is performed at a control node in the
2 network and further comprising setting a control bandwidth of the control node according to
3 the identified bandwidth mismatches.
- 1 23. The method of claim 22 wherein the analyzing comprises using a fast Fourier transform
2 process.
- 1 24. The method of claim 22 wherein the analyzing comprises using a wavelet transform
2 process.
- 1 25. The method of claim 22 wherein the analyzing comprises using a process that reveals
2 periodicities in a time series.
- 1 26. The method of claim 21 wherein periodic of the peaks correspond to bandwidths of
2 bottlenecks within the network.